
RESEARCH TRIANGLE INSTITUTE

Resource Damage Incidents For Dye and Pigment Industry

Background Document

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Introduction

This report summarizes environmental damage and human exposure cases caused by improper management or disposal of wastes generated by dye and pigment production. Dye and pigment industry files, gathered by the U.S.EPA from EPA regional and State offices, served as the primary information resource for this report. Database searches, primarily involving the Record of Decision (ROD) database, attempted to locate any site remediation decisions that had been made for National Priority List (NPL) sites containing wastes associated with dye and pigment manufacturing. The database abstracts and the different environmental reports contribute to the high variability of available, media-specific, contamination data for each site. For some dye and pigment sites only a short narrative of site conditions was obtained, while other sites have documented extensive soil and ground water sampling data. Monitoring data documenting for particular site contamination were presented in Appendix A.

BASF Corporation-OCM Building Holland, Michigan

Manufacturing at this 28-acre site consists of pigment and pigment intermediates, pigment dispersions, and varnishes primarily for the printing ink, paint, and plastics industries. The OCM building was used for the production of dye and pigment intermediates in the late 1930's. Some of the intermediates produced in the building included IC-2 (2-amino-5-chloro-para-toluene sulfonic acid), Hadamines (HAD), IC-30 (2-chloro-meta-toluene sulfonic acid), 2B acid (6-amino-4-chloro-meta toluene sulfonic acid) and 4B acid (6-amino-meta-toluene sulfonic acid). Wastes also entered the OCM Building, including wastewater from the production of phthalocyanine crude that flowed through a trench from the Phthalocyanine digest tank area to a sump in the OCM Building, where it was pumped to the plant sewage system. This waste water treatment train existed from 1963 until 1965 when a deep injection well was constructed to receive the phthalocyanine production wastes, and thus no longer

diverting them through the OCM Building. The process chemical, trichlorobenzene (TCB) and its biodegradation products of other chlorobenzenes, was the greatest concern at the BASF facility. This five phase investigation of soil and ground water contamination around the site of the now demolished OCM Building began in 1990 with boring and sampling 31 holes through the basement floor.

Phase I - OCM Basement Soil Borings - The investigation began with boring and sampling 31 holes in the basement floor to an approximate depth of 1 foot. The samples were concentrated near the trenches and sumps. The chemicals identified in these samples included 1,2,4-trichlorobenzene, IC-2, IC-30, Fuchsine and methyl violet. Soil pH ranged from 7.6 to 9.2.

Phase II - OCM Basement Deep Soil Borings - Continuous soil borings were made at 29 of the 31 sites previously sampled. The samples were taken to depths at which no discoloration or odors were observed. Discoloration and odors were observed at depths of up to 13 feet, 12 feet, several at 10 feet but most discoloration was limited to less than four feet and odorous samples were limited to two feet among these borings. A TCLP analysis was made of composite samples from the east side of the basement and this analysis indicated the soil need not be disposed as hazardous waste. After the floor, walls, and discolored soil were removed from this portion of the basement, a concrete pad with curbs and a central drain to the plant process sewer system were installed converting it to a storage area. The soil borings from the west side of the basement displayed discoloration and organic chemical odors to the top of the water table. This portion of the basement was left intact until the extent of the contamination could be determined.

Phase III- Passive Soil Gas Survey - Twenty-eight passive samplers were set out in and around the OCM Building. A seventeen day exposure period was shown to be sufficient for loading of the target compounds. Benzene, toluene, ethylbenzene, and xylenes were

distributed widely over the sample area. Chlorobenzenes including monochlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, and 1,2,4-trichlorobenzene were detected in three areas. The largest of these areas was a plume emanating from the OCM building; the second was to the west of the Tank Farm Building; and the third and smallest plume lay east of the first plume. Trichlorobenzene was found predominately near the OCM Building site, with smaller contamination areas found near the Tank Farm Building. Dichlorobenzenes were also detected near the OCM Building site and had higher relative fluxes than the trichlorobenzene. Dichlorobenzenes were also found north of the Tank Farm Building. The monochlorobenzene was found in three sites: north of the Tank Farm Building, in the vicinity of the OCM Building, and east of the main plume. These analyses indicated that the west side of the OCM building was the primary source for the chlorobenzene contamination. The detection of chlorobenzenes occurred mainly in the vadose zone and it was hypothesized that the chlorobenzene compounds resulted from the degradation of trichlorobenzene. Tetrachloroethane was also identified in the soil gas survey. This compound was not used in any of the dye processes, however, it was widely used as a degreaser when the Holland Furnace company occupied the site as a foundry and furnace manufacturing company.

Phase IV - Soil Boring and Monitor Well Installation - Additional soil borings were taken and three monitoring wells were installed. Thirty-six soil samples were taken from seven borings and analyzed for various organic compounds. Six were analyzed for the full spectrum of organic priority pollutants and the others were analyzed for only benzene, ethylbenzene, toluene, xylene, monochloro-, dichloro-, and trichlorobenzenes.

Phase V - Sampling and Analyses of Ground-water - Samples were taken from the three monitoring wells and five production wells which were screened in the water table aquifer. Each sample was analyzed for priority pollutant metals and standard volatile and semi-volatile organic chemical compounds. Other organic constituents, such as dye products

and intermediates, were not included for either the soil or ground water samples. The analytical results for the soil boring samples are shown in Table A-1. The process chemical, trichlorobenzene, was found in the soil borings closest to the OCM/PCN site. The other chlorobenzenes, which were assumed to be degradation products of trichlorobenzene, were found further away. Trichlorobenzene may have been lost from process sewers, sumps and vessels during manufacturing. It was postulated that trichlorobenzene most likely migrated into the soil as a solute in the process water and was biologically degraded by anaerobic bacteria to the other chlorobenzenes found on the site. The ground water samples all contained concentrations of at least one constituent that exceeded regulatory limits, as shown in Table A-2. The ground water gradients at the site have been influenced by on-site production wells, which may have slowed the off-site migration of the contaminants.

In addition to the contamination resulting from the OCM building, a waste water outfall from BASF contributed to sediment and water contamination in Lake Macatawa. In August, 1986, an on-site bioassay study on Outfall 004 was performed. The effluent from Outfall 004 was acutely toxic to the test species Daphnia magna. The Daphnia results indicate that Outfall 004 was not in compliance with Rule 82 of the Michigan Water Resources Commission Water Quality Standards. 3,3'-Dichlorobenzene (DCB) was detected in two composite and six grab samples from Outfall 004. The DCB concentrations ranged from 4.5 to 7.2 ug/l at Outfall 004, while the concentration of DCB detected in Lake Macatawa was 1.4 ug/l. The DCB concentrations in the discharge and in Lake Macatawa water exceeded the Rule 57 (2) allowable level of 0.4 ug/l DCB.

On August 28, 1986, Michigan Department of Natural Resources staff conducted a complaint response investigation regarding contaminated sediments in Lake Macatawa. During the course of the investigation, the staff noted organic chemical odors in several soil samples. 1,3-Dichlorobenzene, 1,4-Dichlorobenzene, 1,2,4-Trichlorobenzene, Hexachlorobenzene, and PCB were detected in several samples. The near shore and on shore

samples all contained blue and/or red-colored wastes. This observation is consistent with citizen complaints that colored sediments are present. "These results indicate that a shoreline or on-shore source of contamination is present" (Personal memo from James Turek, March 11, 1987).

Blackman-Uhler Chemical Spartanburg, South Carolina

The Blackman-Uhler Chemical company, a division of Synalloy, has been manufacturing azo dyes and pigments since 1954 at a facility in Spartanburg, South Carolina. The facility is located on a 51-acre site in a low density, mixed-use (residential/ recreation/ industry) area east of central Spartanburg. Single-family homes and several factories are located near the plant, with industrial facilities concentrated across the road from Blackman-Uhler. The residents near the facility have been reported to use city water supplied by a reservoir upstream from Blackman-Uhler.

In terms of water resources in the Blackman-Uhler area, there is a small, unnamed stream close to the plant boundary, which ultimately discharges into Croft State Park Lake. Surface water (Croft State Park Lake, large streams such as Kelsey Creek into which the Blackman-Uhler stream flows) in the area is used for recreation, including recreational fishing, and for irrigation of ornamental plants and golf courses. There are ground water aquifers under the Blackman-Uhler site; there is a shallow aquifer, as well as, bedrock aquifers. Water flow under the site is towards the stream at the southern boundary of the plant and some ground water discharges into the stream.

Several of the textile dyestuffs reported to have been made at Blackman-Uhler include: Azoic Blue 3, Azoic Red 6, Azoic Violet 1, Azoic Black 4, Azoic Brown 9, and Disperse Red 177. The company has also produced smaller volumes of specialty chemicals, such as pesticides and pharmaceuticals. There are six production areas at the facility: the mixing and

presscake process, the nitration process, the disperse dyestuff production, the dyestuff and naphthol production, the pigment ink production, and specialty chemical manufacturing. The plant produces dyestuffs with batch processing. For dyestuff production, the plant uses a wide variety of raw materials which include naphthols, various dye acids and salts, acids and bases, halogenated and non-halogenated solvents, and aromatics.

Blackman Uhler generates hazardous waste and operates an interim-status facility for treatment and storage of hazardous waste. Process waste water is discharged to an on-site pretreatment facility consisting of a lime contact chamber, primary clarifier, aeration basin, secondary clarifier, and belt filter for sludge dewatering. The pre-treated water is discharged to the Fairforest Creek Treatment Plant of the Spartanburg Sanitary Sewer District. Before the installation of the pretreatment system in 1973-1974, some excess waste water from the plant was allowed to flow overland into a number of holding ponds to percolate and evaporate. During the 1960's, liquids containing oxidized sulfides were allowed to flow downslope toward the southeast boundary of the property. This overland discharge, probably containing mercaptans, created odor problems for the facility's surrounding neighbors. Much of the soil was removed from the hillside in order to eliminate the odor.

The Blackman-Uhler facility previously utilized a surface impoundment/aeration basin to receive hazardous wastewaters, including spent methanol and toluene wastes (F003) and spent xylene waste (F005). Blackman-Uhler first notified EPA of the unit in its Part A permit application in 1980, although reports have the unlined earthen basin being constructed in 1970. Until early 1984, the aeration basin received hazardous waste and only in 1987 was the unit excavated, filled in with new sub soil and lined. A ground water monitoring program initiated by Blackman-Uhler in December 1982, indicated that "the quality of the ground water had been impacted by activities associated with the aeration basin" (SCD 003 349 065, 1992). Clean closure of the unit was not achieved during the November 1987 certified closure and thus, as a result, Blackman-Uhler was issued a post-closure permit effective July

1, 1990. Post-closure activities from the end of 1990 to 1992 consisted of ground water assessments and pump-and-treat ground water remediation using three recovery wells and an air stripping system.

RELEASES

In March 1971, a fish-kill occurred in Croft State Park Lake, which is fed by Kelsey Creek. Concurrent with this event was an overflow of colored wastewater from the Spartanburg Sanitary Sewer District (SSSD) pump station. This Publicly-Owned Treatment Works (POTW) attributed the overflow to a "slug discharge" of untreated wastewater from Blackman-Uhler, and this overflow "may have been responsible for the fish kill" (Exhibit #1, page 15). It is important to note that Blackman-Uhler is the main industrial contributor to this pump station.

In November 1971, the same pump station malfunctioned, allowing an overflow of untreated wastewater into Kelsey Creek. SSSD attributed the cause of the malfunction to a "too rapid discharge of wastewater by Blackman-Uhler to the sewer" (Exhibit #1, page 15). Also, runoff from the central area of the plant has created an impact on the adjacent golf course on several occasions. A catch basin pond on the golf course "has become reddish in color, resulting in complaints from golf course officials" (Exhibit #1, page 16).

"Spills of chemicals have occurred on the property at various times and several have required reports to SCDHEC. Two spills were reported in 1981, one of which, involved 2-ethylhexyl-nitrate" (RSI, 1983).

On March 29, 1984, South Carolina Department of Health and Environmental Control (SCDHEC) personnel conducted an Interim Status Inspection at Blackman-Uhler. Findings included containers of hazardous waste that were leaking or badly deteriorated. Based on ground water monitoring data (summarized in Table B-1), Blackman-Uhler has violated

section 48-1-90 of the South Carolina Pollution Control Act in that "it is unlawful for any person, directly or indirectly, to throw, drain, run, allow to seep or otherwise discharge into the environment of the State organic or inorganic matter, except as in compliance with a permit issued by SCDHEC".

MONITORING DATA

Surface Water

No quantitative data that monitored the surface waters surrounding the site was located in the files. However, the following qualitative description was reported for an on-site, spring-fed creek that was sampled upstream and downstream from the plant. With the exception of the upstream sample, the December 1982 and February 1983 results showed slightly elevated levels of iron and manganese. Also, the levels of chlorides, sulfates, phenols and organic carbon at the downstream sample point were greater than at the upstream sample point, "probably reflecting some seepage of these pollutants from the ground water into the creek" (Exhibit #1, page 14). It is likely given the water level readings from the monitoring wells, that the creek intercepts the upper levels of the ground water aquifer.

Ground Water

Annual ground water quality assessment reports have been completed for the Blackman-Uhler site for the years 1986 to 1993. Some of these reports were missing the appendices that contained ground water sampling data. Therefore, while the data presented in Table B-1 is accurate, there may be additional chemical concentrations that were detected in the ground water during a particular year. While many chemicals were detected at various concentrations across many monitoring wells, Table B-1 lists the maximum value detected among all monitoring and recovery wells. In terms of its concentration, chloro-methyl-benzenamine is the major organic constituent reported at the site. Although not a hazardous constituent (as listed in Appendix IX of 40 CFR 264), chloro-methyl-benzenamine has been analyzed since 1989 and was added to the list of ground water protection standards (GWPS)

parameters by the SCDHEC in 1991. "A review of water quality data collected during the post closure care period indicates an increase in the detection limits of many of the semi-volatile organic constituents related to interference from high concentrations of chloro-methyl-benzamine" (1992 Annual Report, page 7).

The First Quarter 1993 Corrective Action Report stated "the corrective action system is effectively controlling the horizontal and vertical movement of constituents in the saprolite aquifer, thereby preventing off-site migration of contaminants" (Blackman-Uhler, 1993 Annual Report).

Ciba-Geigy Corporation Toms River, New Jersey

The manufacturing facility, presently owned by the Ciba-Geigy, has been in operation since 1952 and is composed of numerous buildings, an industrial wastewater treatment plant, and a lined reservoir for emergency storage of treated and untreated wastes. This 1,400 acre site was used for the manufacture of a variety of synthetic organic pigments, organic dyestuffs (including anthraquinone and azo dyes) and intermediates, and epoxy resins from 1952 to 1988. The wastes from these operations were disposed on-site at various locations. The waste sites included a drum disposal area; a lime sludge disposal area; a filtercake disposal area, five backfilled lagoons, and a calcium sulfate disposal area. The drum disposal area, lime sludge disposal area, and the filtercake disposal area were all closed and capped around 1978. Ground water contamination resulting from these inactive disposal sites, is migrating easterly towards the Toms River. Numerous aromatic dye intermediates seem to be present in the ground water at Ciba-Geigy. Anthraquinone is especially prominent; this is consistent with the RI/FS Work Plan that reported two buildings in the production area were devoted to anthraquinone storage. Glycol ethers also are prominent among the compounds that appear to be present in the ground water. The ground water plume from the plant has migrated under residential houses located on the eastern boarder of the plant. Residents in

the neighborhood are on city water, except for pools and lawn irrigation systems in the area are on private wells. When residents had the city come in and test their pool water, the wells were condemned because of chemical contamination.

Currently, Ciba-Geigy generates both liquid and solid wastes. The liquid wastes are treated onsite in a wastewater treatment plant before being discharged to the Atlantic Ocean. The solid wastes are disposed off-site. Following EPA investigations, the sites landfill reportedly was leaking as early as 1981. The discovery of this leaking precipitated remedial measures by the State including the order for Ciba-Geigy to close part of the landfill and monitor groundwater and leachate. In 1984, after discovering that Ciba-Geigy was illegally disposing of drums containing liquids and hazardous waste in the landfill, the State ordered the removal of 14,000 drums. In 1985, leaking equalization basins from the wastewater treatment plant led to closing of the basins and remediating the contaminated groundwater in the upper aquifer. Contaminants were present in leaking drums, waste sludges, soils, and groundwater. The primary contaminants of concern include VOCs such as benzene, PCE, TCE, and toluene and metals including arsenic and chromium. The remedial action included sealing contaminated residential irrigation wells to prevent human exposure and ground water remediation with a monitored pump and treat system that discharges directly to the Toms River, which is also monitored.

ICI Americas Inc. Dighton, Massachusetts

The ICI Americas Dighton facility is approximately 200 acres, of which the manufacturing portion occupies approximately 25 acres. The Taunton River is located approximately 900 feet east of the site and a 24-acre reservoir, used for cooling water, is located west of the manufacturing facility. Muddy Cove Brook flows west to east from the reservoir, through the middle of the ICI Americas property, to its confluence with the Taunton River.

ICI Americas purchased the Dighton site in 1950 and today primarily manufactures textile dyes (60% of production), along with bromochlorofluorocarbons and halothane. Some of the other products manufactured in the past include agricultural chemicals, super plasticizers, and electrochemicals. The Dighton facility production processes are batch processes that are carried out in a variety of departments and buildings. Many of these processes, departments, and buildings have contributed to the site contamination as identified during a visual site inspection (VSI) conducted by U.S.EPA in September, 1987 and a sampling visit for the RCRA Facility Assessment Report dated March, 1989. The following site areas and Solid Waste Management Units (SWMUs) are highlighted as areas of contamination associated with dye production and/or dye waste management. Actual analytical sampling results for these areas were available but were not presented in this report because the legend denoting footnotes to the data was missing from the files.

The MP department is a three-story, multi-product, dye and organic chemical intermediates manufacture building. The MP department waste pad, located southeast of the MP building, is designed to hold up to 216 drums. This pad, which has been in service since 1975, has been repaired several times as evidenced by sealed cracks. Some of the dye wastes stored at this pad in the past included distearyl ketone, amino ester, dimethyl terephthalate, and activated alumina with trichlorobenzenes, chlorobenzenes, and intermediates from fusilade production. Releases to soil in the MP department waste pad area were assessed through collection of shallow soil samples. All samples in this area showed extensive, semi-volatile organic contamination to include dichlorobenzenes, trichlorobenzene, and benzofluoranthenes.

The S department is a three-story, multi-product, dye and organic chemical intermediate manufacture building. This building has been in service since 1923 and produces polyamide fibers (Nylamine dyes). During the visual site inspection, the outer south wall of the S department building and the soils surrounding the wall were stained blue. The exact nature of this blue contaminant on the building wall is unknown. However, some of the

chemicals used in this building are acetic anhydride, chlorosulfonic acid, sodium nitrate, and Indigo 20 Percent Dispersion. Releases to soil from dripping roll-off containers located near Department S were assessed by collecting surface soil samples from the blue-stained soil area observed during the VSI. Samples from this area show semi-volatile organic contamination typical of the ICI facility.

The on-site waste water treatment plant (WWTP) has been in use since 1973. Primarily, the WWTP receives acidic, aqueous waste from the dispersed dye manufacture and alkaline wastes from scrubbers in the MP department. The WWTP final discharge to Muddy Cove Brook is monitored by a NPDES permit. "In the past, color, TSS, and phenol limits have been exceeded several times" (Versar, 1988). Soils adjacent to the primary clarifier tank were dark stained. A red color has been observed in the Taunton River at the point where Muddy Cove Brook discharges to it. This is most likely attributable to the difficulty in getting all of the color from the dyes out of the waste water. Releases to the environment from the WWTP were assessed through the collection of samples in various media. Soils near the primary clarifier were stained red. One volatile organic compound, chloroform, was detected at a very low level in samples collected near the primary clarifier. Semi-volatile organic contaminants typically found at other SWMUs in the ICI facility were also located in these samples. Background surface water and sediment samples were collected from Muddy Cove Brook at a point upstream from the ICI Americas facility. Background surface water conditions were free of volatile and semi-volatile organic compounds and all metal concentrations detected in the background sample are within EPA Ambient Water Quality Criteria (AWQC). The upstream sediment sample is relatively free from contamination by volatile and semi-volatile organic compounds with the exception of low levels of chloroform, fluoranthene, and pyrene. Downstream surface water samples were collected in Muddy Cove Brook immediately adjacent to the effluent gate from the WWTP. Analytical samples reveal extensive occurrence of volatile and semi-volatile organic compounds in surface water adjacent to this effluent gate. The concentrations of vinyl chloride, chloroform,

trichloroethene, and benzene attain or exceed AWQC standards in these samples. Sediment samples also indicate extensive sediment contamination with volatile and semi-volatile organic compounds along reaches of Muddy Cove Brook downstream of ICI. However, most of the semi-volatiles detected in sediment samples were not detected in surface water. This suggests that sediments were, at least in part, contaminated by sources other than releases from the WWTP.

Roll-off containers are located adjacent to the building housing the WWTP sludge filter press. During the visual site inspection, the area around the roll-off containers, as well as the container itself, was stained a dark purple color. "When it rains, some of the sludge 'splashes' out of the container and onto the ground nearby" (Versar, 1988). In fact, the same staining was observed on soils approximately 30 feet away from the container. Releases to the soil from the roll-off container used to hold sludges from the wastewater treatment plant occur when the roll-off accumulated rain water. Soil samples detected two volatile organic compounds, toluene and chloroform, at low levels. Semi-volatile organic compounds typical of soil contamination at other SWMUs at the facility were also detected in this sample area.

ICI operates a landfill southwest of the main plant site. The only wastes disposed of in the landfill are WWTP filter cake sludges, which are transported to the landfill via roll-off containers. The sludges have been generally characterized as a gypsum, carbonaceous biomass originating from the WWTP aeration basins. During sampling to assess soil releases from the landfill, orange-colored ground water was noticed seeping into a sampling hole at 1.5 feet. Releases of volatile and semi-volatile organic compounds were detected near the toe of the landfill, as well as, elevated levels of antimony, nickel, and chromium. During the sampling visit, it was observed that local residents have constructed a low berm behind their homes to prevent drainage from the landfill entering their property. Drainage is diverted westward into a stream.

The Final RCRA Facility Assessment concluded that "sufficient release information has been developed to compel the facility to perform an RFI to determine the nature and extent of soil contamination facility-wide" (Versar, 1989).

Martin Marietta-Sodyeco Division Charlotte, North Carolina

The Southern Dyestuff Company (Sodyeco) site occupies about 1,300 acres located along the Catawba River west of Charlotte, North Carolina and has been used for dye manufacturing since 1936. In 1958 the site was purchased by Martin Marietta and the dye production was expanded to include vat and disperse dyes and specialty products for agrochemical, electronic, explosive, lithographic, pigment, plastic rubber and general chemical industries. In 1983, the Sandoz Chemical Company purchased the plant and has continued to manufacture these product categories.

Sodyeco disposed of wastes onsite since the beginning of its operation. General plant debris and manufactured wastes were routinely disposed in nearby ravines. The wastes identified at the site include sulfur residues and dyes; fiber cloths; empty metal and cardboard drums and cartons; non-acidic, non-flammable chemicals, chemical wastes and construction debris. The primary constituents of concern were PAHs, TCE, and other VOCs. Some of the waste was used as fill material for future manufacturing sites. In two areas identified on the site, drummed chemicals were buried in clay pits as late as the early 1960's. In 1980 Sodyeco discovered groundwater contamination in its drinking water well. Further investigation revealed contamination at a tavern and a convenience store near the facility. Martin-Marietta purchased the tavern and closed it. The convenience store remains open and a carbon filtration system was installed to reduce the concentration of organic solvents at that site. Wells at five other nearby residences and three additional commercial sites were sampled and total VOCs were measured at concentrations ranging from the detection limit to 3 parts per billion. Three of the residences and a gas station were purchased and vacated.

The remaining sites were judged not to be significantly affected, however carbon filter systems were installed and maintained at each off site well by the facility.

A Superfund site inspection of the Sodyeco site was conducted by EPA in April, 1982. In June 1982, EPA analyzed samples of water and sediment taken from adjacent surface water streams, as well as from the extensive ground water monitoring system installed following the discovery of ground water contamination in 1980. On the basis of this collected data, EPA placed Sodyeco on the Superfund National Priority List in 1982.

A Health Assessment investigation conducted at the Sodyeco Site located five areas of contamination. Soil borings, surface water samples, sediment samples, ground water samples, and air monitoring samples were used to characterize the site. Contaminant concentrations measured in soil and ground water are summarized in Table C-1. The following contaminants were identified in the ground water and soil samples: chlorobenzene, o-dichlorobenzene, ethylbenzene, trichloroethylene, tetrachloroethylene, and xylene. No contamination was detected in the surface water samples taken from Long Creek or the Catawba River. Contaminant concentrations in the sediment were very low and not specifically attributable to the Sodyeco site. Based on the air measurements and worst case predicted emissions no air quality problems were identified or expected to exist.

One of the exposure pathways identified for the site is the use of groundwater as a source of drinking water. Although the upper aquifer is not currently used for drinking water purposes, potential use was considered for this investigation. The groundwater discharges into the Catawba River and to Long Creek. Fugitive dust emissions were considered unlikely because Areas A and B are capped by gravel and/or concrete; Areas C and E are well vegetated and Area D is in a low lying grass covered area. Contaminated soil is expected to continue leaching to the surrounding areas. Surface runoff was expected to continue. Surface water contamination of the Catawba River was considered, but the BCF values were very low

for the volatile organic contaminants at the site and although the BCF values for the PAHs are higher, these compounds were also expected not to bioaccumulate in vertebrates such as fish and man. The Catawba River, however, was used as a drinking water source and for swimming and fishing. One indirect exposure pathway considered in the site evaluation was the consumption of local waterfowl and small mammals that may frequent the contaminated area. This pathway was considered likely to be insignificant. Access to the site is limited and no food chain crops are grown on site.

Based on the information provided in the Remedial Investigation for the Sodyeco site, the Health Assessment concluded that there appears to be no current human exposure to site contaminants. However, the vertical and horizontal extent of groundwater contaminant plumes on the site, as well as off-property contaminant migration, have not been completely characterized. Dilution by Long Creek and the Catawba River appears to keep contaminant concentrations in surface waters below detection limits. While current human exposure is not of concern, future exposure may occur if wastes are left in place and remedial measures fail to prevent contaminant migration. For these reasons, the Health Assessment report recommends control/monitoring of future ground water use and monitoring of currently used wells in the immediate vicinity.

The selected remedial action for this site, developed in accordance with CERCLA, is listed below:

GROUNDWATER

- extraction of contaminated ground water
- on-site treatment of extracted ground water
- discharge of treated ground water to off-site stream
- ground water remediation will be performed until all contaminated ground water meets the cleanup goals listed below:

<u>Chemical</u>	<u>Cleanup Goal (ug/l)</u>
trichloroethylene	2.7
tetrachloroethylene	0.8
chlorobenzene	60

ethylbenzene	680
1,2-dichlorobenzene	400
toluene	2,000
xylene	440
anthracene	2.8 ng/l
fluorene	2.8 ng/l
phenanthrene	2.8 ng/l

SOIL

- asphalt cap of Area B (Truck Staging Area)
- excavation and off-site incineration of contaminated soil in Area D (Settling Pond Area)
- on-site treatment of contaminated soil in Area C (Trench Area) to remove organic contaminants

Mobay Corporation/Miles, Inc. Charleston, South Carolina

Two former waste management units at the Charleston facility are regulated by the Resource Conservation and Recovery Act: the holding pond and the equalization pond, both of which have undergone corrective action. Both of these ponds were closed as regulated units by 1989. The holding pond was closed by removing all sludge to the equalization pond.

The 1987 quarterly ground water analysis identified elevated concentrations of total organic carbon (TOC) and sulfate (SO_4) and higher values of pH in monitoring wells downgradient of the holding pond. The 1989 ground water monitoring results verified that low concentrations of four organic waste constituents (o,p-toluidine, p-chloroaniline, chlorobenzene, 1,2-dichlorobenzene) have entered the uppermost aquifer of the ground water system. Annual ground water monitoring data for the Holding Pond and the Equalization Pond are presented in Table D-1.

Beginning in 1986, the equalization pond has been under corrective action which has primarily involved pumping contaminated ground water from the recovery well system. Quarterly ground water samples for the equalization pond between 1988 and 1989 suggest

that there may be an area of degraded ground water near a piezometer not intercepted by the recovery well. 1989 data suggest that the recovery system at the former equalization pond was not performing as designed. In 1990, Mobay was in the process of redeveloping the recovery wells, repairing discharge plumbing and implementing the first phase of a hydrogeologic investigation to expand the recovery system. For the 1991 fourth quarter analyses of the holding pond, the mapped concentrations of VOC's and BNA's compare closely to the distribution of elevated indicator organisms.

At Mobay, 2 SWMUs, a drum wash station and a drum wash drain, comprise the drum wash area where the drums are cleaned prior to being compacted. The wash water from this process flows in a pipeline from the wash station drain to the drum wash sump where it proceeds to drain to the WWTP for treatment. A second drain located outside the fence occasionally accepts surface spills from the drum wash sump and the drum wash station. The variability of drummed wastes and products at the facility influences the composition of wastes present at the drum wash area.

Two soil samples were taken from the drum wash area in 1987. Of the eight priority pollutant metals detected, zinc was detected at the highest concentration in both samples at concentration of 29 ppm and 43 ppm. The pH of the soil was measured at 10.9 and 11.9. Aniline, 4-chloroaniline, di-n-octylphthalate, and phenol were detected at concentrations at or above 150 ppb but not exceeding 480 ppb. Other detected chemicals from the 1987 soil sampling are listed below:

<u>Chemicals</u>	<u>Soil Conc.</u>
methylene chloride	39 ppb (avg.)
acetone	180 ppb (avg.)
octachlorodibenzodioxin	2.56 ppb

The soil drum wash area was again sampled in 1989. Of the 17 metals detected in the 1989 soil samples, only calcium and manganese were identified to be present at significantly higher

concentrations in the samples from downgradient soils.

A 1991 RCRA Facility Investigation evaluated whether or not the soils in the drum wash sump and/or the drum wash drain were releasing wastes into the ground water. The following chemicals were detected in ground water samples downgradient from the drum wash station.

<u>Chemicals</u>	<u>Maximum Conc. (ug/l)</u>
benzene	6.6
chlorobenzene	150
1,2-dichlorobenzene	1,500
1,3-dichlorobenzene	29
1,4-dichlorobenzene	140

The drum wash drain/drum wash sump area may have been responsible for releasing constituents into the ground water as supported by the elevated concentration of the above chemicals detected in samples from downgradient well W-110, and the fact that only low concentrations of 1,2-dichlorobenzene (9.9 ug/l) was detected in samples from upgradient well W-108. This conclusion is further substantiated by the detection of p-chloroaniline, pyridine, ethyl methansulfonate, and 1,2-diphenylhydrazine only in samples from downgradient well W-110.

National Starch and Chemical Company - Leland, North Carolina

From 1971 to 1978, the National Starch and Chemical Company (NSCC) disposed of approximately 350,000 gallons of reaction vessel wash waters in open unlined trenches in the 5-acre site behind the facility. These were corrosive wastes (D002) with a pH less than or equal to 2.0. They consisted of salt brines, sulfuric acid solutions, sulfonating fats and oils, and solvents. The trenches were approximately 250 feet long and 9 feet deep and ran both north/south and east/west. These trenches also received liquid effluent from the plant. When

the percolation rate declined the trenches were backfilled and seeded. In 1976 and 1977, ground water monitoring revealed contamination adjacent to or within the trench area. In 1978, the state requested that onsite disposal of waste cease. Since that time wastes have been pretreated on site and discharged to the local POTW.

The NSCC facility manufactured textile finishing and custom specialty chemicals. The site was bordered by warehousing to the east, a farm to the south and residential areas on the southwest and north sides. The aquifer beneath the site was used as a source of drinking water with the closest well 2,200 feet northeast of the facility. There were 1,539 homes within a three mile radius of the site. These homes did not have access to city drinking water supplies and thus were likely to use ground water for drinking and other domestic purposes. There also was potential for exposure and consumption of contaminated surface water through the recreational use of nearby creeks which receive the runoff from the trench area of the site. The estimated cost of the remediation is estimated to be \$3,036,000 with annual operation and maintenance expected to be \$55,000.

Nyanza Chemical Ashland, Massachusetts

The Nyanza site was placed on the U.S.EPA National Priority List (NPL) in 1982. The site was formerly the location of Nyanza Chemical Company, which operated as one of the largest dye manufacturers in the U.S. from 1965 until 1978. Currently, the site is an approximately 35-acre, partially fenced area.

The 14-acre western portion of the Nyanza site is located on the northern section of Megunko Hill and has been fenced since 1981. Historically, Megunko Hill is an underdeveloped area that was owned and utilized by the dye manufacturing facility for the surface and subsurface disposal of sludge, barrels, process wastes and debris. Two open lagoons, originally constructed as sludge disposal pits, are contained within the area of this

site. A low lying industrial area located on the eastern portion of the site, is the location of the former Nyanza, Inc. dye manufacturing facility. Although dye manufacturing no longer occurs here, industrial activity still exists in this area. An active railroad line runs along the northern edge of this area parallel to an intermittent stream named Chemical Brook. Northwest of the site, a wetland was found to contain disposed wastewater treatment sludge and contaminated sediment from runoff originating at Megunko Hill. The Trolley Brook Wetlands area received septic and waste effluent from settling lagoons, as well as, runoff from the Megunko Hill area. Although the two wetlands are hydrologically connected, an abandoned trolley bed physically separates the two wetland areas.

In 1967, Nyanza produced 76 different types of dyes and 48 dye intermediates. The previous companies located at the site were also involved in the production of various types of dyes and pigments, such as azo and anthraquinone dyes. The raw materials used by Nyanza include acids, bases, aniline, chlorinated benzenes, nitrobenzene, benzidine, 1-naphthylamine, 2-naphthylamine, o-dianisidine (3,3'-dimethoxybenzidine), p-cresidine, o-tolidine (3,3'-dimethylbenzidine), phosgene, cobalt, chromium, mercury, benzoic acid, dichloroaniline, nitroaniline, phenol, bromine, and acrylate monomers.

Nyanza, Inc. maintained several systems to handle the wastes from its various manufacturing processes. Acidic wastewater containing organic and inorganic chemicals was collected in an underground vault before being pumped to a neutralization tank on the hill where sludge precipitated out of the wastewater. This sludge was also allowed to settle in unlined lagoons and ponds and the effluent was discharged to Trolley Brook and the Trolley Brook Wetlands. The sludges were either disposed of on the Megunko Hill surface or in pits. A portion of the solid waste from chemical precipitations and from dye pigment filtering processes was put in 55-gallon drums and buried in different areas of the site. Recovered solvents (e.g., nitrobenzene and phenol), catalysts (e.g., mercuric sulfate), residues from the recovery processes, and bad batches of dyes were disposed throughout the site.

During the plant's operation, chemical emissions into the ambient air were common occurrences. "Between 1918 and 1938, three fires are known to have occurred at the dye manufacturing facility. Numerous instances of chemical releases into the air are known to have occurred based on citizen complaints to the town and investigations of odor, smoke, and fume releases. Releases are known to have occurred due to faulty equipment, bad batches of dyes, human error, malfunctioning scrubber systems, and the lack of scrubbers. Chemicals known to have been released include oleum (fuming sulfuric acid and free sulfate), nitric acid, bromine, sulfur dioxide, sulfide, methyl methacrylate, ethyl acrylate, and benzyl chloride. (MDPH 1993, page 5)." In 1974, the Massachusetts Department of Public Health (MDPH) issued an order to Nyanza to abate the odor nuisance which resulted in the installation of an acrylate scrubber. After being discovered in on-site wetland soils in the summer of 1989, dimethyl mercury was detected sporadically in ambient air samples. One of the samples had dimethylmercury levels above the Agency for Toxic Substances and Disease Registry (ATSDR) recommended action level.

Under orders from the Massachusetts Department of Water Pollution Control (MDWPC) to abate pollutant releases to Massachusetts waters, Nyanza's waste water treatment system was tied into the MDC sewer system between 1970 and 1973. The MDC required Nyanza to install a pH control system to monitor the effluent discharge, to remove waste water bypass lines leading to Chemical Brook, and to reduce the mercury content of the waste water. Between 1970 and 1972, several environmental assessments performed for the EPA and MDWPC indicated that the mercury contamination in the Sudbury River, groundwater, and nearby areas originated from the Nyanza site. In 1986, the MDPH in coordination with the DEQE and the Massachusetts Division of Fish and Wildlife (MDFW) issued a health advisory warning against the consumption of fish from the Sudbury River and its associated reservoirs because of the elevated mercury levels in fish.

"In 1986, the Department of Environmental Quality Engineering (DEQE) discovered

an underground cement vault that was used as a settlement basin for wastewater. After review of the soil samples collected by the DEQE and the EPA, the ATSDR notified EPA's Oil and Hazardous Materials Section that a release of chemicals was occurring. An Interim Remedial Measure Was completed in June 1988. It involved off-site disposal of 2,500 tons of solidified sludge from the vault and treatment of about 14,000 gallons of water. Of the approximately 665 tons of soil adjacent to the vault that were removed, 309 tons were incinerated with disposal of the ash on Megunko Hill and 356 tons were shipped off-site to an approved landfill."

The Remedial Action Master Plan (RAMP) was completed in 1982 after the site was placed on the NPL. As part of the RAMP, the site was divided into three operable units. For Operable Unit I, the Record of Decision (ROD) recommended excavation of hot spot areas, stabilization, landfilling in the cells on Megunko Hill, the capping of Megunko Hill, and the installation in bedrock of a ground water and surface runoff diversion trench upgradient of the cap. From 1985 to 1987, further monitoring of Sudbury River sediment, fish, and surface water was conducted. The DEQE culverted the Chemical Brook in 1985, and shortly thereafter placed one foot of clean fill over the yard of a nearby residence. The first operable unit remedial action was completed in September 1992. The second operable unit was concerned with the future impact of site contaminants on private bedrock water supply wells. The OU II remedy includes institutional controls in the form of private well permit restrictions to limit the potential exposure to site related contaminants. The third phase of the cleanup at the Nyanza site was selected in April 1993. This remedy involves the removal of mercury-contaminated sediments from drainageways between the property formerly owned by Nyanza, Inc. and the Sudbury River. Dewatered sediment would be disposed of under the on-site cap constructed as part of an earlier cleanup. In addition, the ROD creates a fourth phase of cleanup under which the EPA will conduct further studies to assess a final remedy for the Sudbury River.

Nyanza Sampling Results

Generally, on-site environmental media were not monitored for hazardous compounds associated with on-site dye manufacturing activities such as benzidine, o-tolidine, dye stuffs and intermediates resulting from these compounds. Chlorinated and nitrated phenols, anilines, and benzenes were also purchased by Nyanza and were detected in on-site media. However, the monitoring for these compounds was erratic. Contamination at the Nyanza site has been investigated by different state and federal environmental agencies, as well as private contractors. A summary of the environmental monitoring for each media is discussed below, with the sampling data tables being presented in Appendix A. The comparison value contaminant concentrations in specific media are included in the tables to screen contaminants for further consideration. The data table for Nyanza contain the following acronyms:

CREG	= Cancer Risk Evaluation Guide
EMEG	= ATSDR Environmental Media Evaluation Guide
RMEG	= Reference Media Evaluation Guide
MCL	= EPA Maximum Contaminant Level
MCLG	= EPA Maximum Contaminant Level Goal
RfD	= EPA Reference Dose
LTHA	= EPA Lifetime Health Advisory

In 1971, EPA collected vertical composite samples of sludge from the underground vault, which had collected wastewater in the past. Generally, higher contaminant levels were detected in the deeper composites which were generally discolored and pink. The solidified sludge (2,518 tons) was excavated from the vault and disposed of off-site in 1988. The maximum chemical concentrations detected in the vault sludge are presented in Table E-1.

Between 1984 and 1989, surface and subsurface soil samples were collected from various places within the study area including the hill, the northwest wetland, the Trolley Brook - lagoon area adjacent to the vault, and the low-lying industrial area. The soil data are presented in Table E-2.

Between 1973 and 1989, surface water samples were collected from various on-site sources including the basins on Megunko Hill, the northwest wetlands, Trolley Brook, and the low-lying industrial area. The surface water data are presented in Table E-3. The public health assessment concluded that the chemical concentrations detected in on-site surface water do not represent a threat to human health.

In 1985, seven sediment samples from the northwest wetlands, Trolley Brook wetlands, and low-lying industrial area were collected and analyzed for heavy metals. Wetland sediment data are presented for Table E-4.

For the description of on-site ground water contamination, the site was divided into the Megunko Hill and the low-lying industrial area. Ground water data is presented in Table E-5. Current ingestion of contaminated ground water is unlikely because no off-site private water supply wells are known to exist in the area of the ground water plume. Future ingestion is possible, but not very likely.

In 1989, prior to the excavation of onsite soils and wetlands, monitoring of dimethylmercury in ambient air was conducted for baseline determinations. Ambient air monitoring for dimethylmercury was conducted for breathing zone samples obtained at the Megunko Hill area perimeter. Ambient air data are presented in Table E-6.

During the preliminary investigation for OU II, analysis was conducted of 21 vertical composites of subsurface soil samples obtained during the installation of off-site monitoring wells near residential homes. Off-site soil data are presented in Table E-7.

Off-site surface water were collected from different locations at various times between 1972 and 1989 and are presented in Table E-8. The Mill Pond sampling location is a portion

of the Sudbury River and the Cherry Street location is a stretch of the Chemical Brook.

Off-site sediment samples were collected from the same locations as the off-site surface water samples. The concentrations of the VOCs and the semi-VOCs generally ranged from the low parts per billion to less than 20 ppm. Off-site sediment data are presented in Table E-9.

Between 1971 and 1989, fish samples were collected from various locations around the Nyanza site. Compounds detected in the fish were mercury, lead, chromium, methyl mercury, Aroclor-1254, 4,4'-DDD, 4,4'-DDT, and 3,3'-DDE. Concentrations of these contaminants are presented in Table E-10.

The greatest off-site ground water contamination has been detected in the wells adjacent to the site, specifically northeast of the vault. The concentrations of contaminants detected in off-site ground water samples are presented in Table E-11 and were collected from overburden and bedrock wells to the north and east of the site.

Ott/Story/Cordova Chemical - North Muskegon, Michigan

Various specialty organic chemical manufacturing facilities have operated at this site since 1957. Their products have included dyestuffs, pharmaceuticals, and agricultural chemicals. Ground water and soil contamination were reported as early as the 1960's, probably due to leaching from unlined lagoons and leaking from drums of waste accumulated on site. The lagoons received discharge from production vessel clean out wastes and wastewaters. Due to contamination of drinking water wells, alternate water supply was provided to residents in the vicinity of the site. Ground water recharge of surface water caused significant degradation of Little Bear Creek and its unnamed tributary. The primary chemicals of concern at this site include benzene, tetrachloroethylene, trichloroethylene,

1,2-dichloroethane, toluene, vinyl chloride, xylene, polychlorinated biphenyls, pesticides, and metals including arsenic. Cleanup costs were estimated to be \$1,014,000 with an initial operation and maintenance cost of \$10,000 and an annual operation and maintenance cost of \$7,500 for the second year.

Sandoz Chemical Company Martin, South Carolina

Sandoz Chemical Company's Martin, South Carolina production facility is a major producer of azo dyes, as well as organic chemical intermediates. The Sandoz facility is situated on 4,600 acres in a sparsely-populated, heavily-wooded area on the Savannah River. The Sandoz Plant is bounded by both the river and by the U. S. Department of Energy's Savannah River Plant. The nearest residential housing is approximately one mile from the plant border.

The wastewater treatment system at Martin was designed as shown in the diagram (Figure 1). Standard parts of the system included neutralization, settling and biodegradation basins and lagoons. Originally, Sandoz had an unlined equalization basin in which the acidity of wastewaters was adjusted; sometimes the acidity in this basin was at a pH below 2. When RCRA went into effect, Sandoz had to close down this equalization basin and install an equalization tank. An unusual feature of the wastewater treatment system was its final process step: a spray field located above a layer of sandy soil. Final clarification of treated wastewater was to occur as the liquids percolated through the sand on the sprayfield. It has been reported that the sand layer in the spray field does a good job of removing color, and the effluent is clear just a few feet down into the sand layer although the wastewater sprayed on the field is black. The assumption, which led to initial incorporation of the sprayfield in the waste disposal plan, was that the clay layer under the surface sandy soils was a solid sheet without holes. The wastewater cleaned by the sandy layer was supposed to move into groundwater at the level of the clay and then discharge into the Savannah River, keeping effluent away from the deeper aquifers below the clay. It turned out that this was not the

case; the clay layer had holes and leaked, and contaminants were thus able to migrate from the superficial sand layer into the aquifer beneath.

In 1983, the Dry Branch aquifer below the surface sandy layer under the Martin site was found to be contaminated; this conclusion was based on finding contamination in downgradient monitoring wells. In a February 10, 1984 memo, the South Carolina Department of Health and Environmental Conservation (SCDHEC) staff recommended that an order be issued requiring that Sandoz stop using the spray field for disposal of wastewater, that the aquifer be monitored to determine the extent of contamination, and that steps be taken to clean up the contamination. In June 1984, it appeared that Sandoz would stop spraying wastewater in certain parts of the sprayfield, those parts deemed "vulnerable."

A Comprehensive Ground Water Monitoring Evaluation was conducted at Sandoz Chemical on November 11, 1985 by U.S.EPA, Region IV representatives. The major finding from this report was that "the contamination parameters from EPA and the facility's data indicate that a ground water problem exists at the facility and an appropriate assessment should be implemented to address the problem." In support of this conclusion, Table F-1 contains ground water quality data taken from monitoring wells located upgradient and downgradient from the equalization basin.

In September 1987, a SCDHEC memo stated that contamination of the aquifer below the sprayfield constituted a violation of both State environmental regulations and the Sandoz facility's wastewater permit.

As of 1989, Sandoz and SCDHEC were preparing an agreement to perform groundwater recovery in the sprayfield area of the Martin site. The company planned to stop using the sprayfield within four years, and to build a wastewater treatment system which would discharge into the river.

EPA sampled sludges and sediments as well as liquids from the basins and lagoons, and sampled soil from the spray field (see Table F-2). Sludges, sediments and liquids from the basins and lagoons of the waste treatment system contained organic chemicals typically used in production processes at the Martin Plant. The soil from the spray field did not contain any of these chemicals.

The history of releases for the Sandoz Chemical Facility in Martin, SC as reported in the 1989 Interim RCRA Facility Assessment Report:

"In 1981, a pipe flange between the Former Equalization Basin (SWMU 4) and the Equalization Tank Pump Station (SWMU 7) ruptured. An estimated 150,000 to 200,000 gallons of waste water from the Former Equalization Basin (SWMU 4) entered Smith's Lake Creek. No fish kill was detected by SCDHEC. A secondary dike was reportedly constructed to ensure such a leak would be contained should such an event reoccur."

"According to the facility representative, in approximately 1979 and in 1981, some effluent from one of the two Large Lagoons (SWMUs 13 and 14) was released through the cooling water line that leads to the percolation area south of the lagoons. According to a SCDHEC representative, effects on ground water from this release are being assessed using data collected as part of the regular ground water monitoring performed by Sandoz as stipulated in the wastewater treatment system construction and operating permits."

Wamchem, Inc. Burton, South Carolina

This site is located on a small island in the midst of a salt marsh near McCalleys

Creek. This tidal stream is considered a habitat for the endangered species, the loggerhead turtle and the short-nosed surgeon. The water table aquifer discharges into the creek and is inseparable from the underlying Floridian Aquifer. The site was owned and operated from 1959-1972 by the Beaufort, Chemical and Research Company, producing dyes for the textile industry. Between 1972 and 1981 it was owned and operated by the M. Lowenstein Company performing solvent recovery and recycling operations. Wastes at this site were discharged into a drainage ditch that drained into two unlined ponds. Another ditch led directly from one of the unlined ponds to McCalley Creek. In 1972, the waste system was changed to an unlined holding pond and a lagoon, which was then replaced by two spray fields and a concrete lined holding pond in 1975. Ground water contamination was documented at the site in 1982. The chemicals identified included, benzene, toluene, xylenes and semi-volatile and nonvolatile organics. The estimated cost of remediation was \$1,310,000 with an annual operations and maintenance cost of \$155,100.

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APPENDIX A - SAMPLING DATA

Table A-1 BASF-OCM Building. Analytical Results from Soil Boring Study

Sample No.	BETX (mg/kg)	Benzenes (mg/kg)				
		Mono-Cl	1,2-diCl	1,3-diCl	1,4-diCl	Tri-Cl
B#1 14-1	ND	ND	ND	ND	<0.07	22
B#1 17-1	ND	ND	ND	ND	0.29	23
B#1 17-2	ND	ND	ND	ND	ND	25
B#1 17-3	ND	ND	ND	ND	0.29	23
B#1 19-2	ND	0.043	ND	2.6	7	4
B#1 20-4	ND	0.024	ND	1.6	2.5	3.3
B#1 21-7	ND	ND	ND	ND	ND	ND
B#2 10-1	ND	ND	ND	ND	<0.09	18
B#2 10-2	ND	ND	ND	ND	ND	14
B#2 16-1	ND	0.0073	ND	2.5	6.4	42
B#2 16-2	ND	0.13	ND	3.5	7.5	6.7
B#2 18-1	ND	ND	ND	ND	ND	ND
B#3 8-1	ND	ND	ND	ND	ND	6.2
B#3 9-1	ND	ND	ND	ND	0.1	5
B#3 10-1	ND	ND	ND	0.49	0.36	1.2
B#3 10-3	ND	ND	ND	1.2	0.39	7
B#3 11-1	ND	ND	ND	0.66	0.54	0.84
B#3 12-1	Toluene <0.002	0.33	ND	2.4	15	0.48
B#3 13-2	benzene=0.0085 toluene=0.0064 xylene=0.0072	0.23	ND	0.95	8.5	ND
B#3 14-1	ND	ND	ND	ND	ND	ND
B#4 10-1	ND	ND	ND	ND	ND	ND
B#4 13-1	ND	ND	ND	ND	0.081	0.43
B#4 14-1	ND	ND	ND	ND	ND	ND
B#4 15-1	ND	ND	ND	ND	ND	ND
B#5 12-1	ND	ND	ND	ND	ND	0.43
B#5 15-1	ND	ND	ND	1.4	0.96	0.42
B#5 16-2	ND	0.2	ND	< 0.1	0.71	0.33
B#5 17-1	ND	ND	ND	ND	ND	ND
B#6 8-2	ND	ND	ND	ND	ND	ND
B#6 9-1	ND	ND	ND	ND	<0.02	ND
B#6 16-2	ND	ND	ND	0.42	0.28	ND
B#6 16-1	ND	ND	ND	ND	ND	ND
B#7 4-2	toluene=0.0058	ND	ND	ND	ND	ND
B#7 8-1	ND	ND	ND	ND	ND	ND
B#7 13-2	ND	ND	ND	ND	ND	ND
B#7 14-1	toluene=0.0028	ND	ND	ND	ND	ND

Table A-2 BASF - OCM Building. Analytical Results from Ground Water Monitoring Well Study

Constituent	Production Wells					Monitoring Wells		
	Well A	Well B	Well C	Well E	Well H	MW-1	MW-2	MW-3
Metals								
Arsenic (ug/L)	1.7	1.2	1.8	<1.0	<1.0	<1.0	<1.0	1.1
Antimony (ug/L)	<2.0	<2.0	2.2	<2.0	<2.0	<2.0	<2.0	<2.0
Nickel (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.02	<1.0
Copper (mg/L)	<1.0	<1.0	0.08	<1.0	<1.0	<1.0	<1.0	<1.0
Zinc (mg/L)	<2.0	<2.0	<2.0	<2.0	<2.0	0.14	<2.0	<2.0
Volatile Organic Compounds								
Benzene (ug/L)	2	<1.0	1	1	1	<1.0	<1.0	<1.0
Chlorobenzene (ug/L)	25	<1.0	33	<1.0	<1.0	<1.0	1	<1.0
Chloroform (ug/L)	<1.0	<1.0	<1.0	<1.0	8.5	<1.0	<1.0	<1.0
1,2-Dichloroethene (total) (ug/L)	<2.0	<2.0	<2.0	<2.0	3	<2.0	<2.0	<2.0
Ethylbenzene (ug/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5
Tetrachloroethene (ug/L)	<2.0	<2.0	<2.0	<2.0	<2.0	4	<2.0	<2.0
Trichloroethene (ug/L)	<2.0	<2.0	<2.0	<2.0	<2.0	3	<2.0	<2.0
Semi-Volatile Organic Compounds								
1,3-Dichlorobenzene (ug/L)	39	<5.0	38	<5.0	<5.0	<5.0	140	<5.0
1,4-Dichlorobenzene (ug/L)	47	<10	45	<10	<10	<10	100	<10
1,2,4-Trichlorobenzene (ug/L)	180	<10	170	<10	<10	<10	59	<10
Well Field Data								
Conductivity (uohm/cm)	945	656	930	704	782	431	706	293
pH	7.56	8.01	7.55	7.51	7.92	8.08	7.88	8.01
Water elevation	605.8	605.07	606.14	607.33	605.52	586.46	585.99	586.33
Well Depth (feet)	- 40	- 40	- 40	- 40	- 40	- 40	- 40	- 40

Table B-1 Blackman-Uhler. Annual Ground Water Quality Assessment
(maximum values reported)

Chemicals	1986 (ug/l)	1987 (ug/l)	1988 (ug/l)	1989 (ug/l)	1990 (ug/l)	1991 (ug/l)	1992 (ug/l)	1993 (ug/l)
chloride	2,500,000							
sulfate	3,000,000							
sodium	2,900,000					961,000*		
aniline			1,350	10,800		2,500		
benzene					124	110	130	
p-chloroaniline		24,000	1,000	26,500	nd	1,500		
chlorobenzene		74	nd	< 150	38	64		
p-chloro-m-cresol	9,300	4,200		10,500	nd	2,200		
chloro-methyl benzenamines				357,000	175,000	29,000	92,000	75,000 #
1,4-dichlorobenzene		100	70	356		nd		
ethyl benzene				930	4,600	4,600	14,000	5,700 #
4-methylphenol						2,600		
phenol		5,110	60	nd	nd	nd		
tetrachloroethene					74	160	250	220 #
toluene	126,000	96,000	42,800	36,000	45,100	87,000	61,000	66,000 #
o-toluidine hydrochloride		7,900	2,240	nd	nd	1,300		
trichloroethene					17	66	100	86 #
xylene					16,500	4,900	17,000	3,800 #
aluminum						8,000*		
barium							180	
calcium						48,000*		
cobalt							130	
iron						21,000*		
manganese						3,500*		
magnesium						18,000*		
nickel							30	

* = results for first quarter 1991 ground water monitoring

= results for first quarter 1993 ground water monitoring

Table C-1 Martin Marietta - Sodyeco. Contaminant Concentrations Measured at the Sodyeco Site

Chemical	Soil Range (ppb)	Ground Water Range (ppb)
Area A		
chlorobenzene	7.9 - 220	
o-dichlorobenzene	27 - 85	
Area B		
xylene	11	
chlorobenzene	5.8 - 6	45 - 720
tetrachloroethylene		15
o-dichlorobenzene		29 - 650
Area C		
chlorobenzene	6.7 - 6,800	320 - 4,400
ethylbenzene	6.1 - 1,700,000	
o-dichlorobenzene	7.4 - 18,000,000	64 - 2,500
xylene	22 - 15,000,000	160
trichloroethylene		22 - 54
tetrachloroethylene		72 - 1,400
Area D		
chlorobenzene	190 - 15,000	14,000 - 15,000
ethylbenzene	45	590 - 2,300
o-dichlorobenzene	23,000 - 6,000,000	
xylene	340 - 27,000	1,700 - 4,800
tetrachloroethylene		56
Area E		
chlorobenzene		510 - 20,000
o-dichlorobenzene		780 - 36,000
xylene		200 - 470

Table D-1 Mobay Corporation/Miles Inc. Chemical Concentration in the Uppermost Aquifer

Year	Holding Pond (mg/l)				Equalization Pond (mg/l)			
	sulfate	total VOCs	total BNAs	arsenic	sulfate	total VOCs	total BNAs	arsenic
1989	51 - 1,248				205 - 1,190	nd - 2,660	nd - 3,630	
1991	24 - 1,900	nd - 121	nd - 155		95 - 890	132 - 497	76 - 1,055	
1993	100 - 1,400	nd - 0.114	nd - 0.044	nd - 0.0364	58 - 1,300	0.039 - 0.286	0.032 - 0.252	nd - 0.123

Table E-1 Nyanza. Vault Sludge Data

Compound	Maximum Chemical Concentration (ppb)		Comparison Value	
	0-4 feet	> 4 feet	ppb	Source
trans-1,2-dichloroethene	35		1,000,000	RMEG
trichloroethene		24,000	60,000	CREG
chlorobenzene		200,000	20,000,000	EMEG
1,2-dichlorobenzene	2,000	1,000,000	5,000,000	RMEG
1,3-dichlorobenzene		72,000	none	none
1,4-dichlorobenzene		340,000	none	none
aniline		15,000	100,000	CREG
nitrobenzene		1,500,000	30,000	RMEG
antimony	151	190	20,000	RMEG
arsenic	9	7	400	CREG
chromium	120	637	300,000	RMEG
mercury	140	237	100,000	EMEG
lead	81	107	none	carc

Table E-2 Nyanza. On-site Soil Data

Compound	Maximum Chemical Concentration (ppm)				Comparison Value	
	Hill	Northwest	Trolley Brook	Low-area	ppm	Source
antimony	1,660			70	20	RMEG
arsenic	36	46	170	63	0	CREG
chromium	2,300	15,000	13,000	2,300	300	RMEG
lead	680	1,400	1,900	750	none	carc
mercury	1,000	4,000	2,100	3,500	100	EMEG
TCE				50	60	CREG
chlorobenzene				330	20,000	EMEG
1,2-DCB				53	5,000	RMEG
1,3-DCB				1.1	none	none
1,4-DCB				9.9	none	carc
aniline				100	100	CREG
nitrobenzene				9,100	30	RMEG
1,2,4-TCB				760	500	RMEG

Table E-3 Nyanza. On-site Surface Water Data

Compound	Maximum Chemical Concentration (ppb)				Comparison Value	
	Hill	Northwest	Trolley Brook	Low-area	ppb	Source
antimony	200			100	4	RMEG
chromium	20		50	26	50	RMEG
lead	10		26.2	13.3	0	MCLG
mercury	1.8	125	118	64	2	LTHA, MCLG
t-1,2-DCE	70	13.3	18.7	26.4	200	RMEG
TCE	19	19	15.8	24	3	CREG
chlorobenzene	9.6			9	200	RMEG
1,2-DCB	120			5.8	900	RMEG
1,4-DCB	28				75	LTHA, MCL
aniline	34				6	CREG
nitrobenzene	260				5	RMEG

Table E-4 Nyanza. On-site Sediment Data.

Compound	Maximum Chemical Concentration (ppm)			Comparison Value	
	Northwest	Trolley Brook	Low-area	ppm	Source
antimony			80	20	RMEG
arsenic	8.4	31.4	5.2	0.4	CREG
chromium	6,600	6,600	656	300	RMEG
lead	1,200	1,200	230	none	carc
mercury	4,985	3,337	1,306	100	EMEG
t-1,2-DCE		22		1,000	RMEG
TCE		89	8	60	CREG
chlorobenzene	44	190	12.5	20,000	EMEG
1,2-DCB	14		1,200	5,000	RMEG
nitrobenzene			1,500	30	RMEG
1,2,4-TCB			1,500	500	RMEG

Table E-5 Nyanza. On-site Ground Water Contamination Data

Compound	Maximum Chemical Concentration (ppb)										Comparison Value	
	Hill			Low Area			Northwest		Trolley Brook Wet.			
	overburden	bedrock		overburden	bedrock		overburden	bedrock	overburden	bedrock	ppb	Source
1,2-dichloroethene (total)	610	700		4,600	390		25	160	82	12,000	none	none
trans-1,2-dichloroethene	546	300		250			250	200	1,030	2,400	200	RMEG
trichloroethene	17,000	15,000		420,000	2,500		500	460	160	2,500	3	CREG
chlorobenzene	540	14		8,600	92			110	76	92	200	RMEG
1,2-dichlorobenzene	780	3,700		2,400				830	185	650	900	RMEG
1,3-dichlorobenzene					65						600	LTHA, MCLG
1,4-dichlorobenzene	174	400		500				89	210	1,750	75	LTHA, MCL
1,2,4-trichlorobenzene				5,100				96	60		100	RMEG
aniline	2,554	2,900		63,400					167	258	6	CREG
nitrobenzene	1,300	1,320		3,600	280					280	5	RMEG
antimony		35			351			39		33	4	RMEG
arsenic	83	140		200			79	32	78	7.1	0.02	CREG
chromium	93	120		9,500			120	71	240	34	50	RMEG
lead	190	210		770			170	70	350	20	0	MCLG
mercury	73.3	10		2,800			10	5.7	110	2.9	2	LTHA, MCLG

Table E-6 Nyanza. On-site Ambient Air Data

Compound	Maximum Chemical Concentration (ng/m3)		Comparison Value	
	Hill	Low-area	ng/m3	Source
mercury	450	48	60	EMEG

Table E-7 Nyanza. Off-site Soil Data

Compound	Concentration (ppm)	Comparison Value	
	Homes	ppm	Source
arsenic	77	0.4	CREG
chromium	160	300	RMEG
mercury	16	100	EMEG
lead	2,300	none	carc

Table E-8 Nyanza. Off-site Surface Water Data

Compound	Maximum Chemical Concentration (ppb)					Comparison Value	
	Mill Pond	NE Wetland	Cherry St.	Reservoir #2	Homes	ppb	Source
1,2-dichloroethene (total)	340	710	23		7	200	RMEG
trans-1,2-dichloroethene		150					
trichloroethene	1.8	420	11	1.1	23	3	CREG
chlorobenzene		370	3.1		19	200	RMEG
1,2-dichlorobenzene	5.8	5.4	5.8		29	900	RMEG
1,2,4-trichlorobenzene						100	RMEG
nitrobenzene	3.2	2				5	RMEG
antimony		22	17	2		4	RMEG
chromium	15.3	14.4	12.3	6	12	50	RMEG
mercury	0.5	36	118	28	18	2	LTHA, MCLG
lead	5.6	6	10	13	95	0	MCLG

Table E-9 Nyanza. Off-site Sediment Data

Compound	Maximum Chemical Concentration (ppm)					Comparison Value	
	Mill Pond	Trolley Brook Wet.	NE Wetland	Cherry St.	Reservoir #2	ppm	Source
trans-1,2-dichloroethene	2.28	2.3	0.008	0.013	0.054	1,000	RMEG
trichloroethene	1.3	89	0.011	0.017		60	CREG
chlorobenzene	13.1	190	0.016	12.5		20,000	EMEG
1,2-dichlorobenzene	49	14	0.61	7.2		5,000	RMEG
1,3-dichlorobenzene			1.6	.		none	none
1,4-dichlorobenzene			18	1.6		none	carc
1,2,4-trichlorobenzene		8.8	7.1	3.1	0.13	500	RMEG
aniline			6.7			100	CREG
nitrobenzene	1.3		18	0.65		30	RMEG
antimony	3.6		6.3	23	18	20	RMEG
arsenic	18.4		12.9	14.9		0.4	CREG
chromium	76	715	988	656	2,620	300	RMEG
mercury	164	152	99	141	190	100	EMEG
lead	361	185	269	230	295	none	carc

Table E-10 Nyanza. Fish Contamination Data

Compound	Maximum Chemical Concentration (mg/kg)					
	Mill Pond	Reservoir #2	Upstream	Sudbury Res.	Saxon Imp.	Heard Pond
mercury	3.4	12.43	0.72	1.6	2.9	1.8
chromium		8.3		2.8	1.7	
lead		0.8			0.9	

Table E-11 Nyanza. Off-site Groundwater Contamination Data

Compound	Maximum Chemical Concentration (ppb)		Comparison Value	
	overburden	bedrock	ppb	Source
trans-1,2-dichloroethene	1,690		200	RMEG
trichloroethene	5,100	58,000	3	CREG
chlorobenzene	7,900	50,000	200	RMEG
1,2-dichlorobenzene	9,600	580,000	900	RMEG
1,3-dichlorobenzene		290	600	LTHA, MCLG
1,4-dichlorobenzene	1,700	56,000	75	LTHA, MCL
1,2,4-trichlorobenzene	2,400	2,300	100	RMEG
aniline	24,000	85,200	6	CREG
nitrobenzene	37,000	3,100,000	5	RMEG
antimony		673	4	RMEG
arsenic	330	69	0.02	CREG
chromium	1,200	46	50	RMEG
mercury	77	45	2	LTHA, MCLG
lead	510	140	0	MCLG

Table F-1 Sandoz Chemical. Analytical Ground Water Summary of Equalization Basin Area (11/05/85)

Chemical/Parameter	upgradient well	downgradient wells		
	SD-06 (ug/l)	SD-07 (ug/l)	SD-08 (ug/l)	SD-11 (ug/l)
conductivity	43 umhos	220 umhos	510 umhos	140 umhos
barium	-	-	69	1,200*
cadmium	-	-	-	18*
chromium	10	-	76*	140*
lead	-	77*	130*	250*
manganese	33	-	630#	1,400#
phenols	36	26	40	450
TOC	1.5 mg/l	2.9 mg/l	7.7 mg/l	17 mg/l

* = value exceeds 1985 National Interim Primary Drinking Water Standards (NIPWS)

= value exceeds national Secondary Drinking Water (SDWS)

Table F-2 Sandoz Chemical. Analytical Sediment/Sludge and Soil Samples (1/23/85)

Sediment/sludge and soil samples	Equalization basin	Sludge Basin #1	Sludge Basin #2	Lagoon #1	Lagoon #2	Spray Field
	S-01S (mg/kg)	S-02S (mg/kg)	S-03S (mg/kg)	S-04S (mg/kg)	S-05S (mg/kg)	S-06 (mg/kg)
barium	1,800	120	78	94	40	9.4
chromium	450	310	70	35	13	3.9
copper	300	380	75	58	19	2.9
molybdenum	22	5.6	-	130	52	-
nickel	36	5.7	-	19	14	2.8
lead	73	-	-	-	-	-
mercury	1.2	0.5	0.8	0.5	0.4	-
manganese	3,200	100	290	110	41	34
magnesium	460	5,200	3,000	440	370	150
iron	42,000	3,100	4,100	2,400	2,900	2,200
sodium	9,400	8,600	7,900	2,800	1,200	-
trans-1,2- dichloroethene	0.065	-	-	-	-	-
trichloroethene	3	-	-	-	-	-
toluene	54	0.97	0.5	0.036	-	0.039
chlorobenzene	0.56	6.7	1.8	0.017	-	-
ethylbenzene	4.4	-	-	-	-	-
m-xylene	11	0.14	0.052	-	-	0.011
mixed xylene	5.3	0.08	0.03	-	-	-
acetone	3.8	3.4	2.2	1.4	0.26	-

Figure 1.

Present Wastewater Treatment Process Flow For Sandoz Chemicals Corporation

